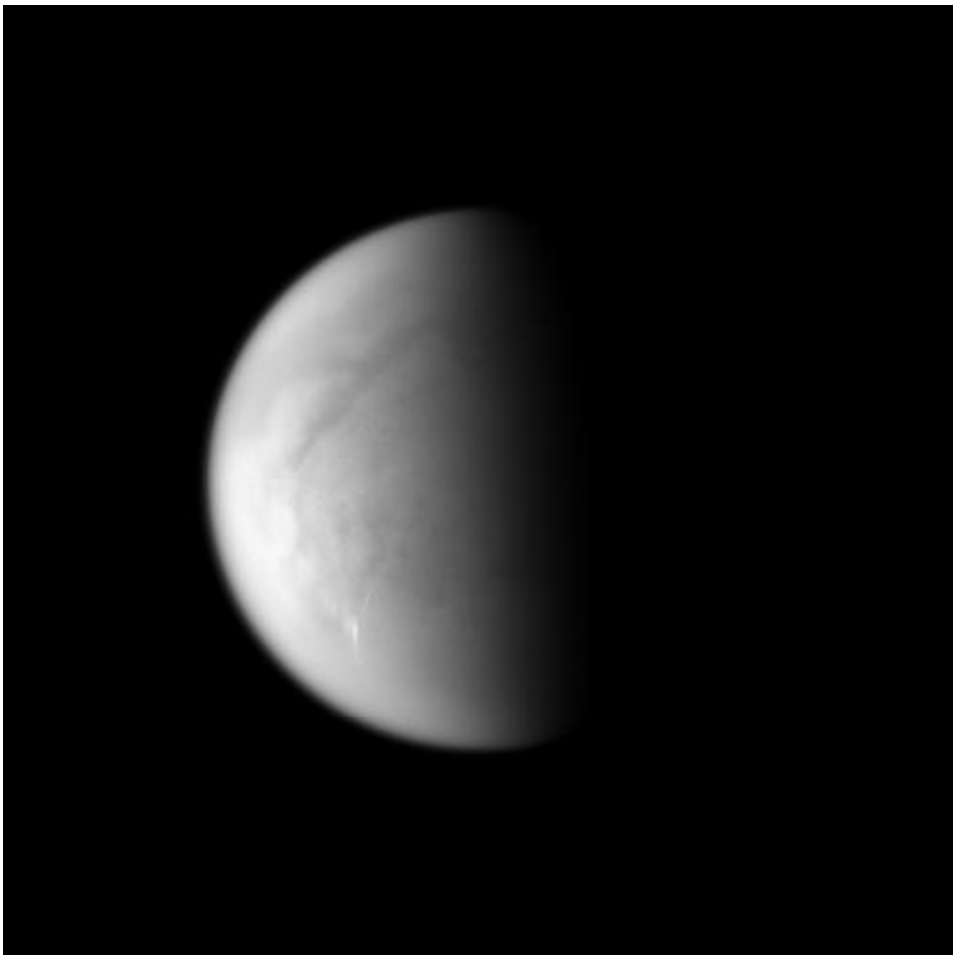
C A S S I N I



TITAN 112TI(T56) MISSION DESCRIPTION

June 6, 2009

Jet Propulsion Laboratory
California Institute of Technology

Cover image: Streaking Through the South

May 27, 2009

Cloud streaks stand out on Saturn's largest moon, Titan.

The tropospheric clouds seen in the lower left of the image are located at 45 to 55 degrees south latitude on Titan, and the streaks of the clouds are oriented east-west. This view looks toward the south pole of Titan. The pole lies near the terminator about a quarter of the way inward from the planet's limb at the bottom of this image.

For a movie of tropospheric cloud activity near Titan's south pole, see South Polar Cloud Movie.

Lit terrain seen here is on the leading hemisphere of Titan (5150 kilometers, or 3200 miles across). The image was taken with the Cassini spacecraft narrow-angle camera on March 24, 2009 using a spectral filter sensitive to wavelengths of near-infrared light centered at 938 nanometers. The view was obtained at a distance of approximately 1.1 million kilometers (684,000 miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 78 degrees. Image scale is 7 kilometers (4 miles) per pixel.

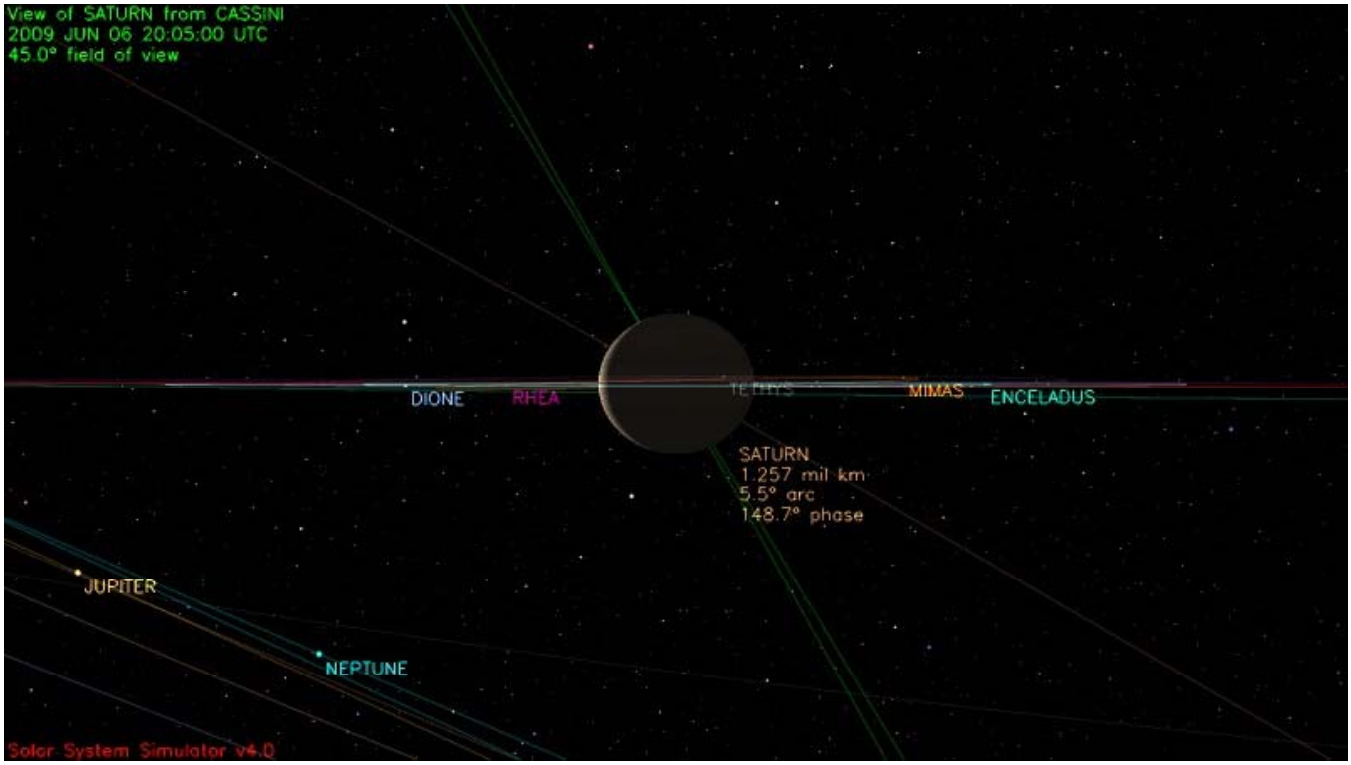
The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

On June 6, 1944, President Franklin Delano Roosevelt spoke on the evening of the D-Day invasion of having "set upon a mighty endeavor", where the "road will be long and hard" Roosevelt noted that "[s]uccess may not come with rushing speed, but we shall return again and again." Sixty-five years later, the Cassini project is in the midst of another type of mighty endeavor. We have travelled a very long and hard road on our way to Saturn, and we now regularly return again and again at high speed to Titan.

Just less than 16 days since its previous visit, Cassini returns to Saturn's largest moon for the mission's fifty-seventh targeted encounter with Titan. The closest approach to Titan occurs on Saturday, June 6 at 2009-157T20:00:00 spacecraft time at an altitude of 965 kilometers (~600 miles) above the surface and at a speed of 6.0 kilometers per second (~13,400 mph). The latitude at closest approach is 32.1 degrees S and the encounter occurs on orbit number 112.

This encounter is set up with two maneuvers: an apoapsis maneuver on May 29, and a Titan approach maneuver, scheduled for June 3. T56 is the fifth flyby in a series of eleven inbound encounters and the twelfth Titan encounter in Cassini's Solstice Mission. It occurs just under three days before Saturn closest approach.


View of SATURN from CASSINI
2009 JUN 06 20:05:00 UTC
45.0° field of view
DIONE
RHEA
TETHYS
MIMAS
ENCELADUS
SATURN
1.257 mil km
5.5° arc
148.7° phase
JUPITER
NEPTUNE
Solar System Simulator v4.0

ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.1 TITAN-56 SCIENCE HIGHLIGHTS

- **RADAR** continues the southern hemisphere mapping sequence. The instrument captures SAR in addition to outbound altimetry, scatterometry, and radiometry. The SAR swath runs parallel to, and partly overlaps, the swath captured in T55, running down from Shangri-La to southern high latitudes.
- **INMS:** INMS will be riding with RADAR on T56. This is the only dusk side observation at mid Southern latitudes. It's the only time in the mission the spacecraft will get simultaneous coverage of the dusk side while in the wake magnetospheric interaction region.
- **CIRS** conducts distant stratospheric composition and temperature mapping to search for seasonal changes
- **VIMS:** On the inbound leg, the phase angle is much larger than 90 degrees and VIMS ridealong observations will provide information on Titan's atmospheric composition. After closest approach, VIMS will observe the South Pole region riding along with CIRS far from Titan. Only cloud monitoring will be possible.
- **ISS** will ride along with VIMS to observe eastern Tsegihi and to monitor clouds over Titan's trailing hemisphere at mid-southern latitudes. There will be no illuminated prime observations.
- **UVIS** has an unusually large number of observations during T55-T60 where the instrument dictates the spacecraft's pointing. All of them are part of an ongoing sequence of requests to acquire latitude, phase angle, and time coverage of atmospheric composition, including Titan's haze. This flyby includes two stellar occultations and several EUVFUV images. The instrument will obtain an image cubes of Titan's atmosphere at EUV and FUV wavelengths by sweeping its slit across the disk. These cubes provide spectral and spatial information on nitrogen emissions, H emission and absorption, absorption by simple hydrocarbons, and the scattering properties of haze aerosols. These are a few of many such cubes gathered over the course of the mission to provide latitude and seasonal coverage of Titan's middle atmosphere and stratosphere.
- **MIMI** measures energetic ion and electron energy input to Titan's atmosphere.

- **MAG**: T56 is another flank-out, post-dusk flyby, with a minimum altitude of 1000 km. As in T55 MAG measurements will provide a description of the draping and the pileup of the external magnetic field around Titan on the nightside hemisphere. It will be also a good complement to T52, T53, T54 and T55 in order to characterize the background field for a similar local time with respect to Saturn and different SKR longitudes.
- **RPWS** will measure thermal plasmas in Titan's ionosphere and surrounding environment; search for lightning in Titan's atmosphere; and investigate the interaction of Titan with Saturn's magnetosphere.

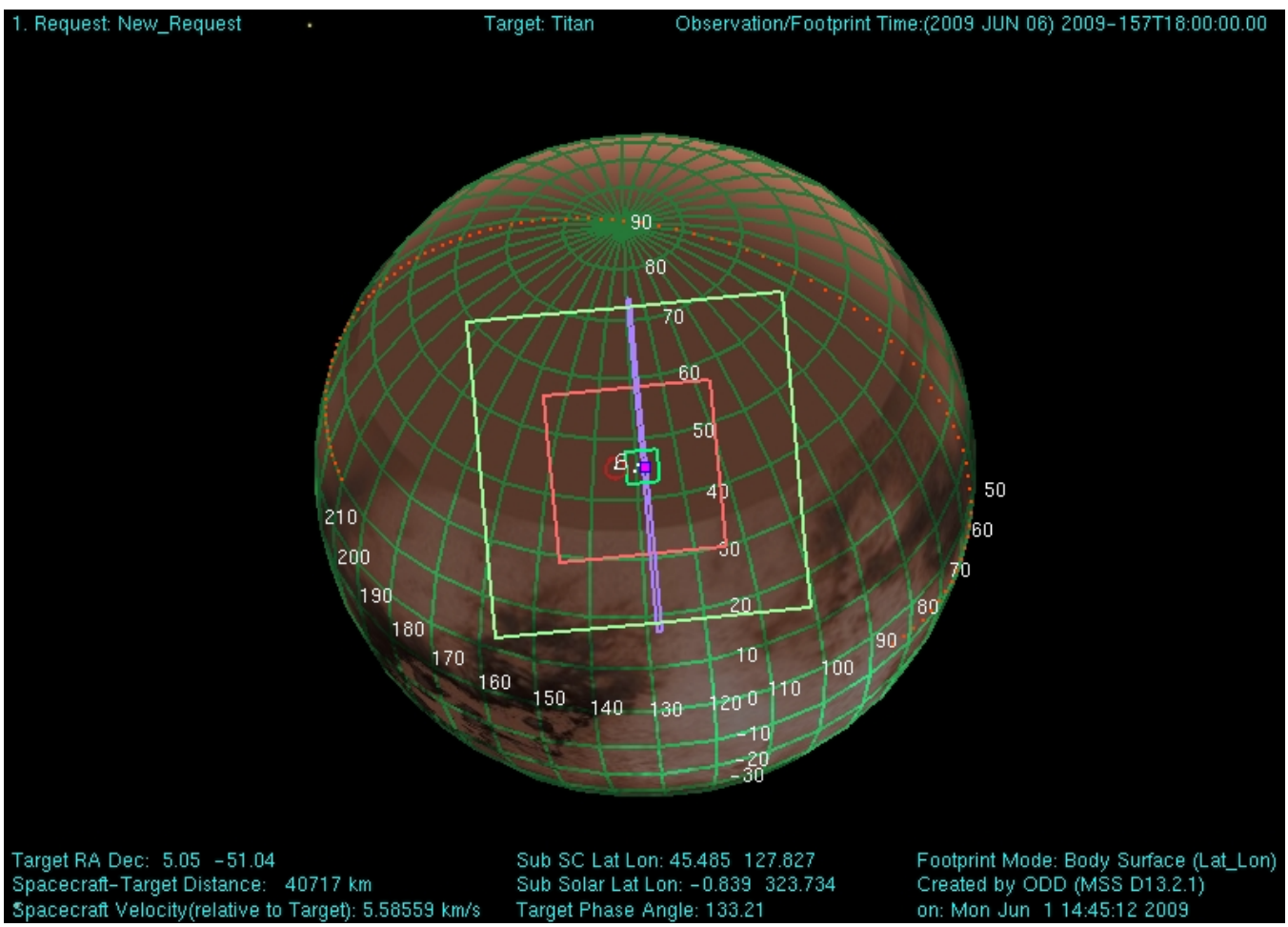
SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

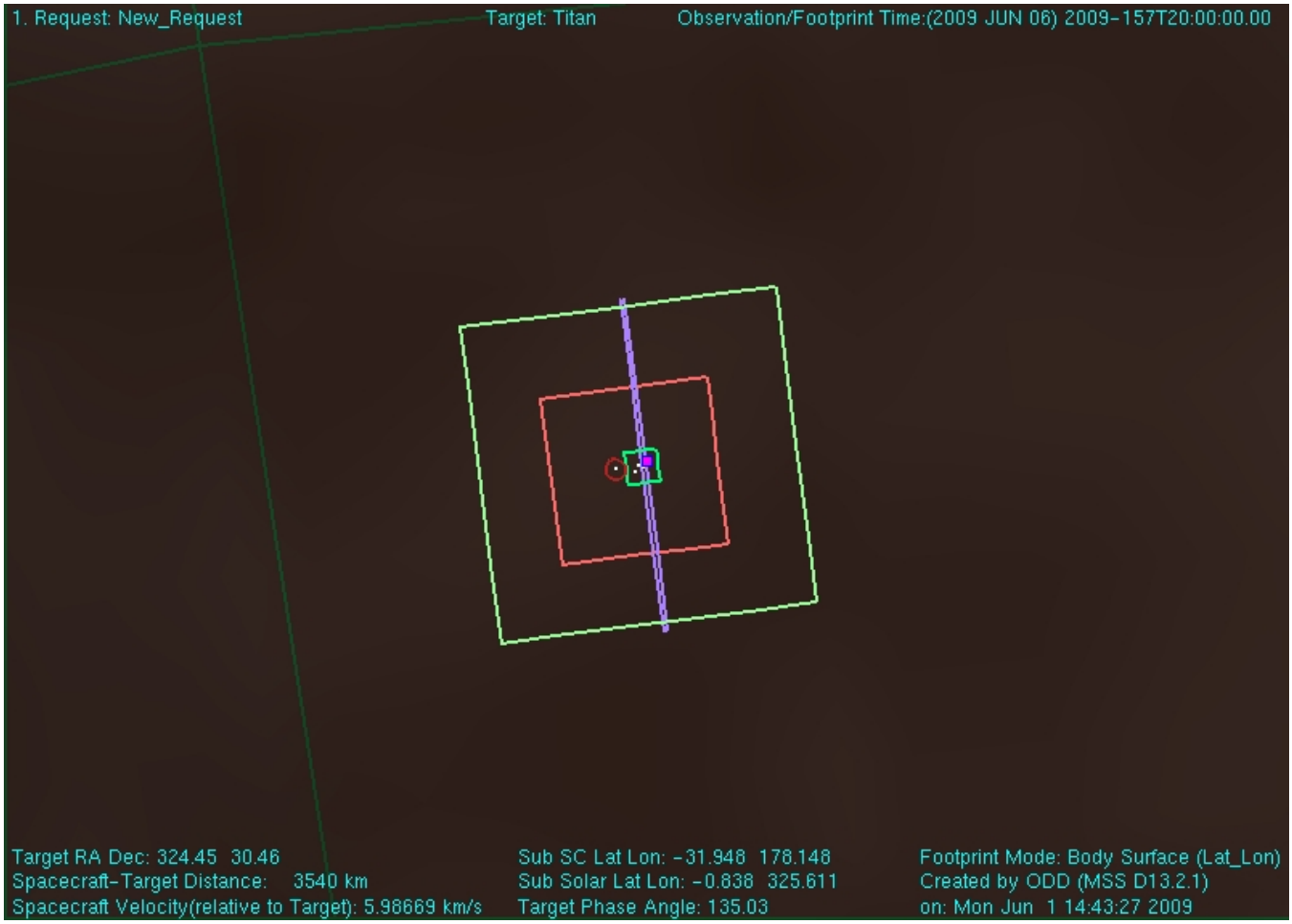
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

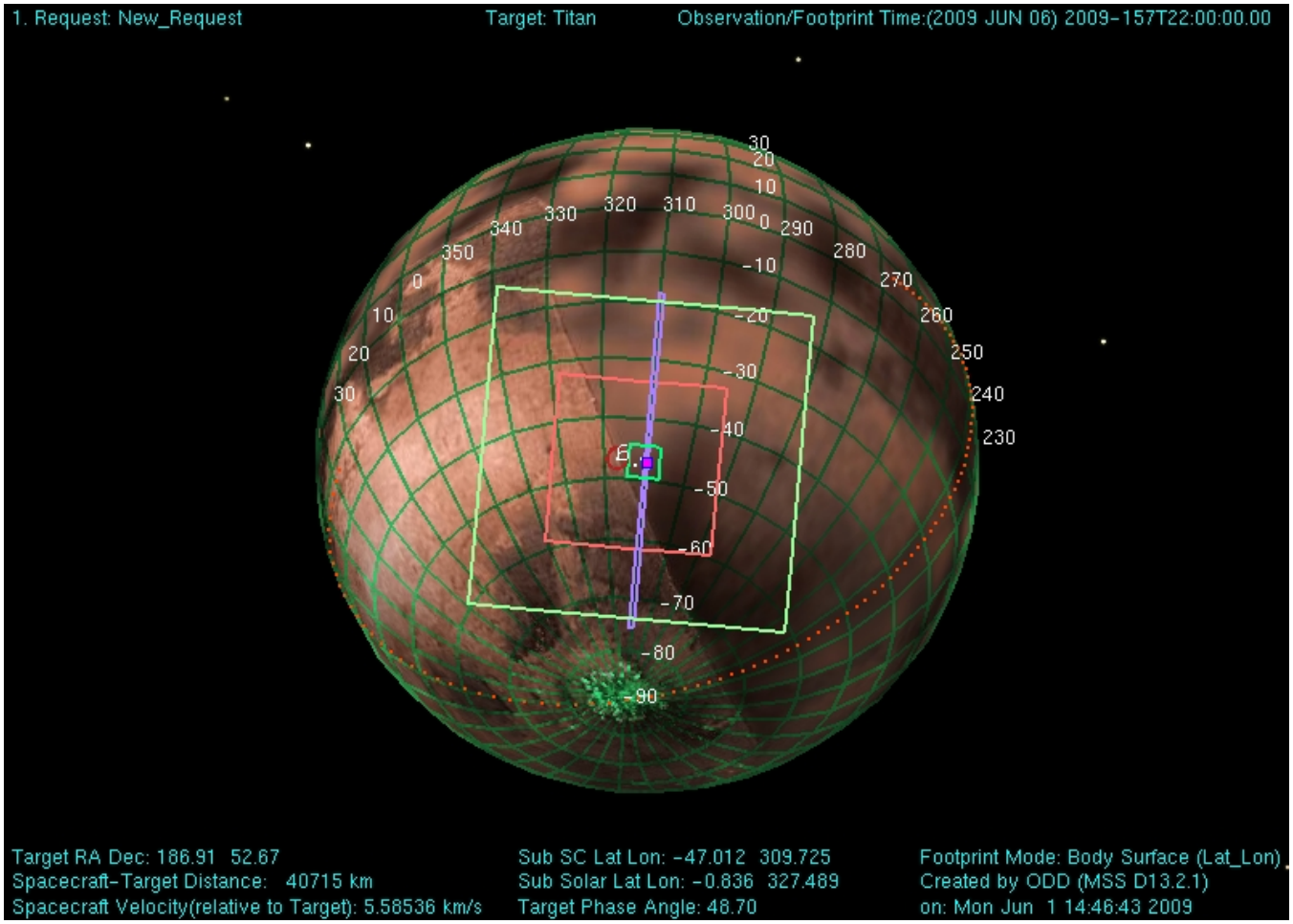
View of Titan from Cassini two hours before Titan-56 closest approach



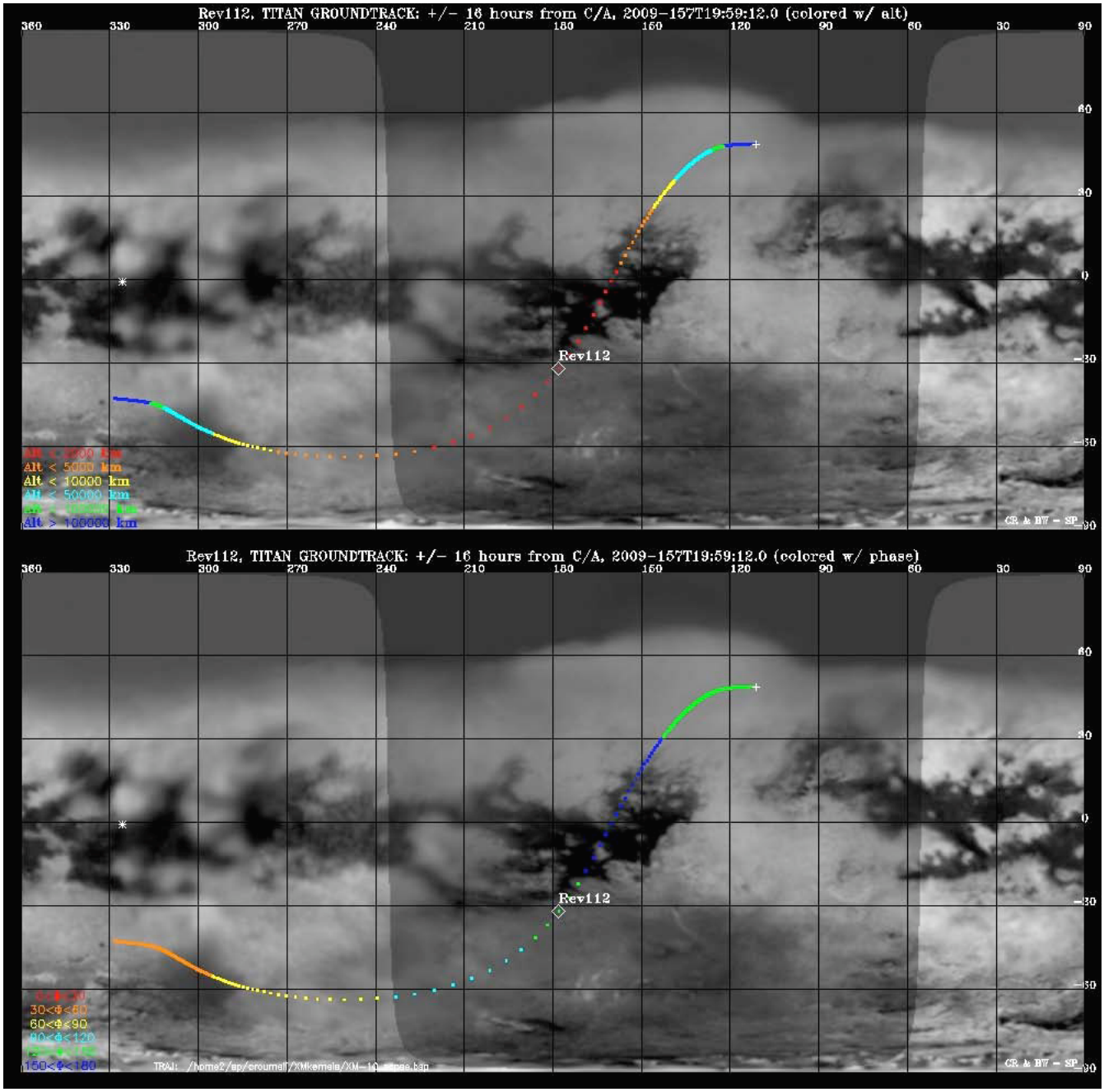
View of Titan from Cassini at Titan-56 closest approach



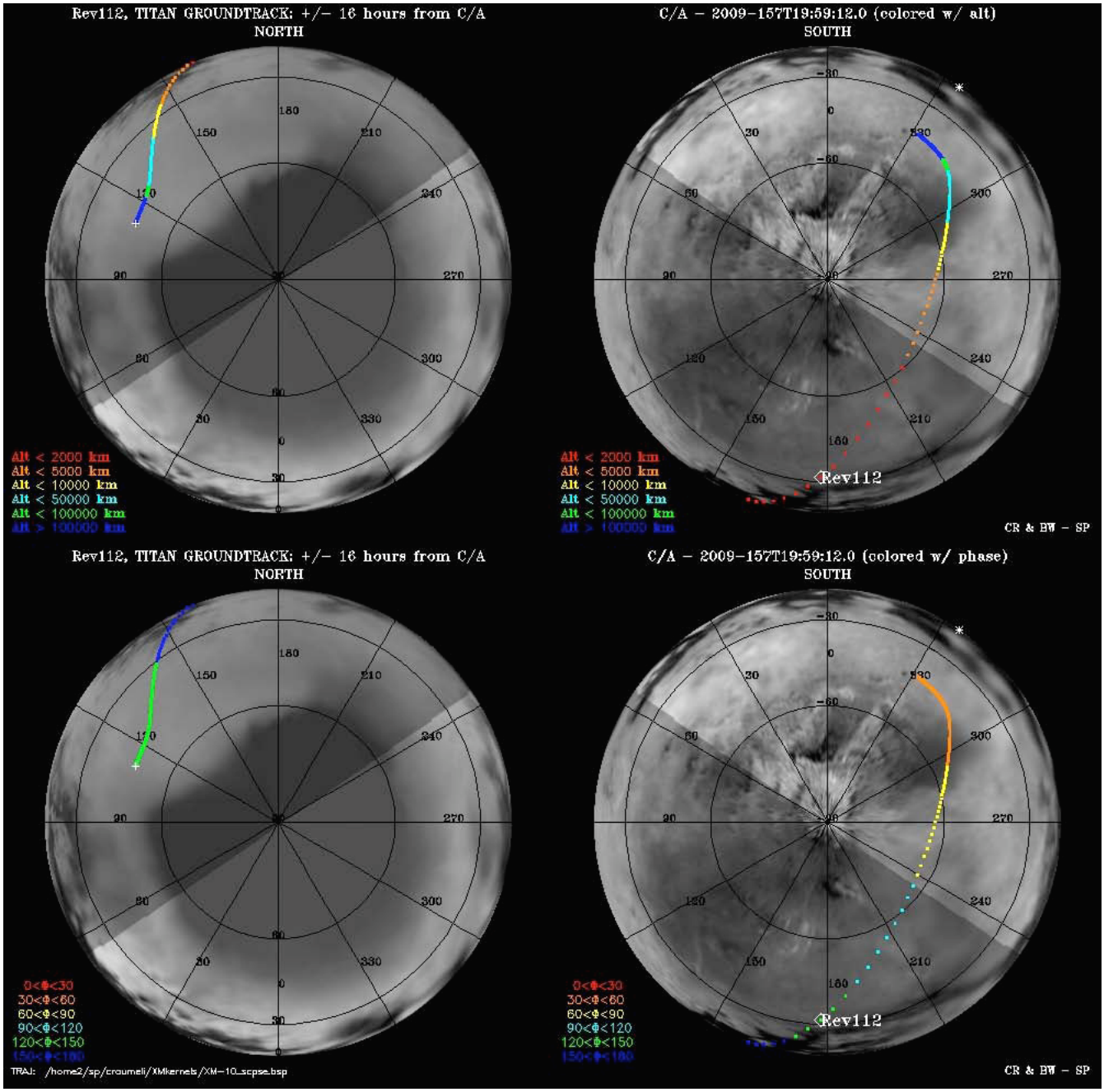
View of Titan from Cassini two hours after Titan-56 closest approach



Titan Groundtracks for T56: Global Plot



Titan Groundtracks for T56: Polar Plot



The T56 timeline is as follows:

Cassini Titan-56 Timeline - June 2009

Colors: yellow = maneuvers; blue = geometry;
pink = T56-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time (PDT)	Time wrt T56	Activity	Description
125T07:16:00	May 05 08:34	Tue May 05 01:34 AM	T56-32d13h	Start of Sequence S50	Start of Sequence which contains Titan-56
154T12:42:00	Jun 03 14:00	Wed Jun 03 07:00 AM	T56-03d07h	OTM #199 Prime	Titan-56 targeting maneuver.
155T12:42:00	Jun 04 14:00	Thu Jun 04 07:00 AM	T56-02d07h	OTM #199 Backup	
157T05:12:00	Jun 06 06:30	Fri Jun 05 11:30 PM	T56-14h48m	Start of the TOST segment	
157T05:12:00	Jun 06 06:30	Fri Jun 05 11:30 PM	T56-14h48m	Turn cameras to Titan	
157T05:52:00	Jun 06 07:10	Sat Jun 06 12:10 AM	T56-14h08m	New waypoint	
157T05:52:00	Jun 06 07:10	Sat Jun 06 12:10 AM	T56-14h08m	Deadtime	15 minutes 49 seconds long; used to accommodate changes in flyby time
157T06:07:49	Jun 06 07:25	Sat Jun 06 12:25 AM	T56-13h53m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
157T10:00:01	Jun 06 11:18	Sat Jun 06 04:18 AM	T56-10h00m	Titan atmospheric observations-ISS	WAC Photometry
157T11:00:01	Jun 06 12:18	Sat Jun 06 05:18 AM	T56-09h00m	Titan surface observations-VIMS	Regional mapping
157T14:50:01	Jun 06 16:08	Sat Jun 06 09:08 AM	T56-05h10m	RADAR	Inbound radiometry
157T18:00:01	Jun 06 19:18	Sat Jun 06 12:18 PM	T56-02h00m	RADAR	Inbound scatterometry
157T18:48:01	Jun 06 20:06	Sat Jun 06 01:06 PM	T56-01h12m	Transition to thruster control	
157T18:49:01	Jun 06 20:07	Sat Jun 06 01:07 PM	T56-01h11m	RADAR	Inbound HiSAR
157T19:30:01	Jun 06 20:48	Sat Jun 06 01:48 PM	T56-00h30m	RADAR	Inbound altimetry
157T20:18:01	Jun 06 21:36	Sat Jun 06 02:36 PM	T56+00h18m	RADAR	Inbound and outbound SAR
157T19:40:51	Jun 06 20:58	Sat Jun 06 01:58 PM	T56-00h20m	Earth occultation	20 minute duration
157T19:42:00	Jun 06 21:00	Sat Jun 06 02:00 PM	T56-00h18m	Solar occultation	19 minute duration
157T20:00:00	**Jun 06 21:18**	**Sat Jun 06 02:18 PM**	**T56+00h00m**	**Titan-56 Flyby Closest Approach Time**	**Altitude = 965 km (~600 miles), speed =6.0 km/s (13,400 mph); 135 deg phase at closest approach**
157T20:18:01	Jun 06 21:36	Sat Jun 06 02:36 PM	T56+00h18m	RADAR	Outbound altimetry
157T20:20:00	Jun 06 21:38	Sat Jun 06 02:38 PM	T56+00h20m	Descending Ring Plane Crossing	
157T20:32:01	Jun 06 21:50	Sat Jun 06 02:50 PM	T56+00h32m	Transition off of thruster control	
157T20:53:10	Jun 06 22:11	Sat Jun 06 03:11 PM	T56+00h53m	Titan atmospheric observations-UVIS	Titan Occults Eta Uma. UVIS FUV Occultation slit boresite on star for entire time.
157T21:41:01	Jun 06 22:59	Sat Jun 06 03:59 PM	T56+01h41m	Titan atmospheric observations-UVIS	EUVFUV Imaging of Titan
158T05:00:01	Jun 07 06:18	Sat Jun 06 11:18 PM	T56+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
158T10:00:01	Jun 07 11:18	Sun Jun 07 04:18 AM	T56+14h00m	Titan surface observations-VIMS	Global mapping
	#VALUE!	#VALUE!	#VALUE!	Titan surface observations-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
	#VALUE!	#VALUE!	#VALUE!	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
158T19:02:49	Jun 07 20:20	Sun Jun 07 01:20 PM	T56+23h02m	Deadtime	14 minutes 11 seconds long; used to accommodate changes in flyby time
158T19:17:00	Jun 07 20:35	Sun Jun 07 01:35 PM	T56+23h17m	Turn to Earth-line	
158T19:57:00	Jun 07 21:15	Jun 07 14:15	T56+23h57m	Playback of T65 Data	Goldstone 34m and 70m
159T01:48:00	Jun 08 03:06	Jun 07 20:06	T56+01d06h	Playback of T56 Data	Canberra 70m